

# Brain Stem

- The brainstem consists of the medulla, the pons and the midbrain.
- The **activities** of the brainstem may be divided into **3 general types**:
  - Conduit functions;
  - Cranial nerve functions;
  - integrative functions.

# Conduit Functions

- The **conduit functions** are apparent, since the only way for **ascending tracts** to reach the thalamus or cerebellum (or for descending tracts to reach the spinal cord) is through the brainstem.
- Many of these tracts, however, **are not straight-through affairs**, and **relay nuclei** in the brainstem are frequently involved.

# Cranial Nerve Functions

- The **cranial nerves** are the **head's equivalent of spinal nerve fibers**;
  - with the addition of special fibers involved in the **special senses** of **olfaction, sight, hearing, equilibrium, and taste**.
- A **wide assortment of sensory and motor nuclei** related to **cranial nerve function** can be found at various brainstem levels.

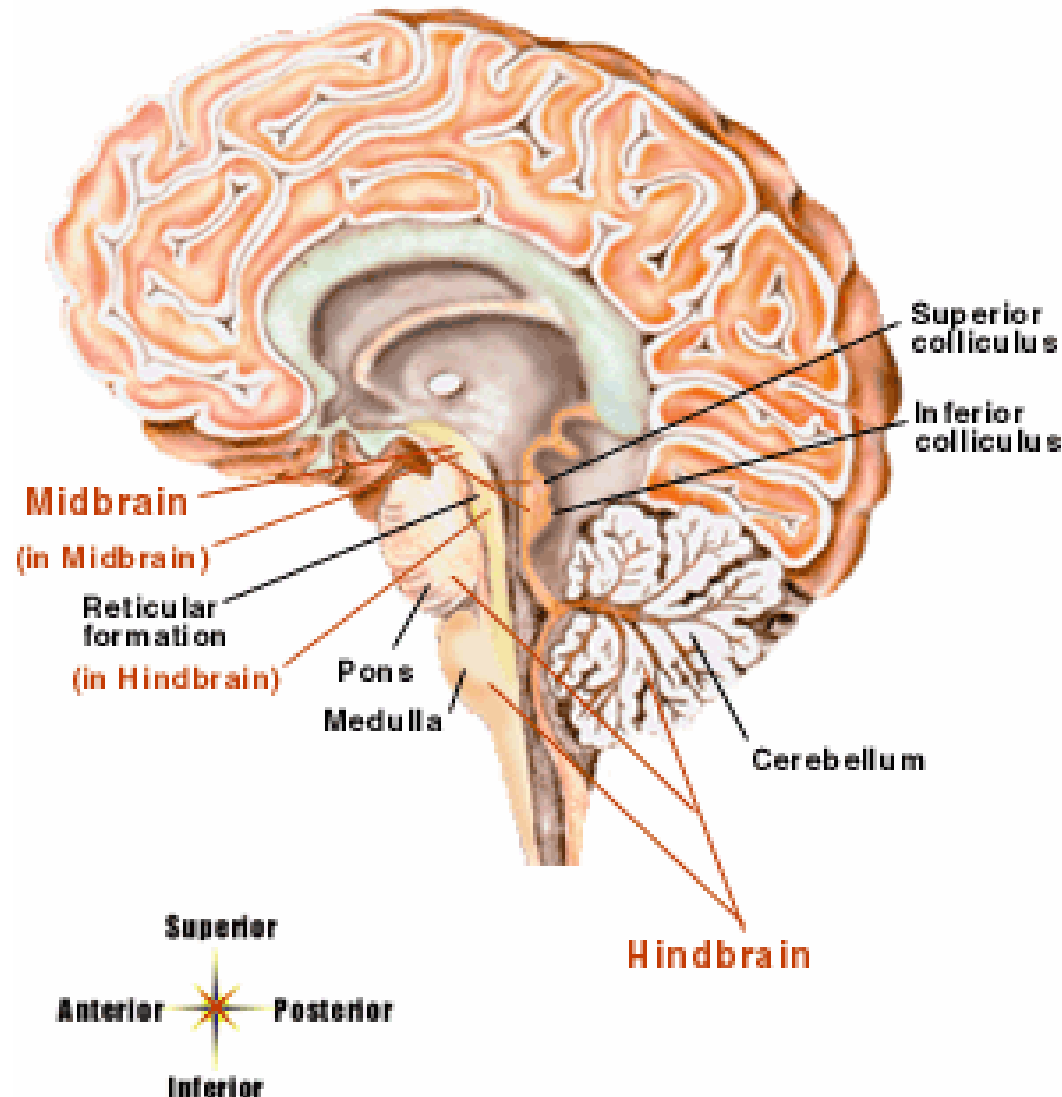
# Integrative Functions

- A number of **integrative functions** are organized at the level of the brainstem.
- These include **complex motor patterns**, aspects of **respiratory** and **cardiovascular activity**, and even some **regulation of the level of consciousness**.
- Much of this is accomplished by the **reticular formation**.

# Internal Structure of the Brainstem

At any given **brainstem level rostral** to the **obex**, **3 general areas** can be identified in **cross section**.

- The area posterior to the ventricular space;
- The area anterior to the ventricular space;
- And **large** structures "appended" to the anterior surface of the brainstem.



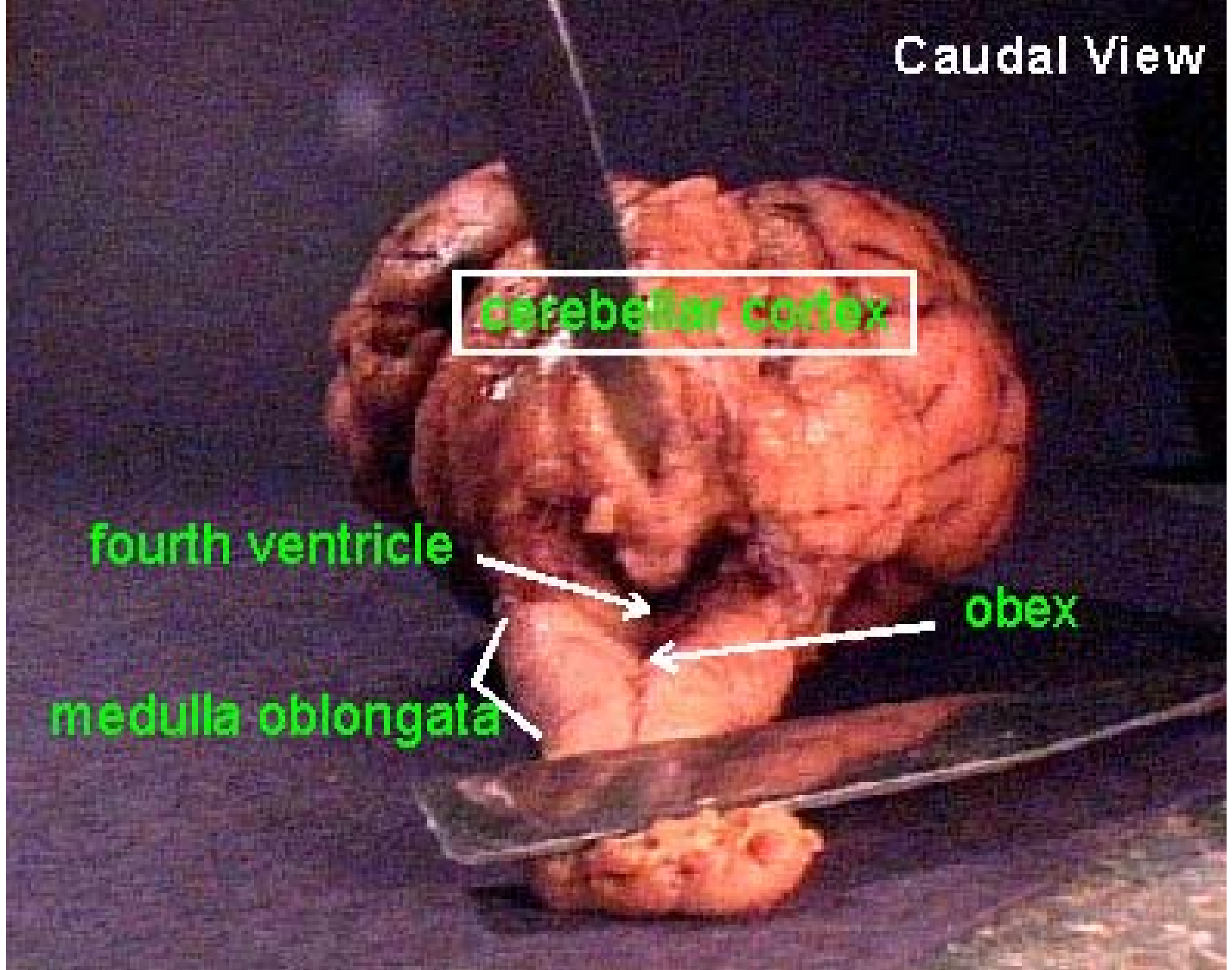
Caudal View

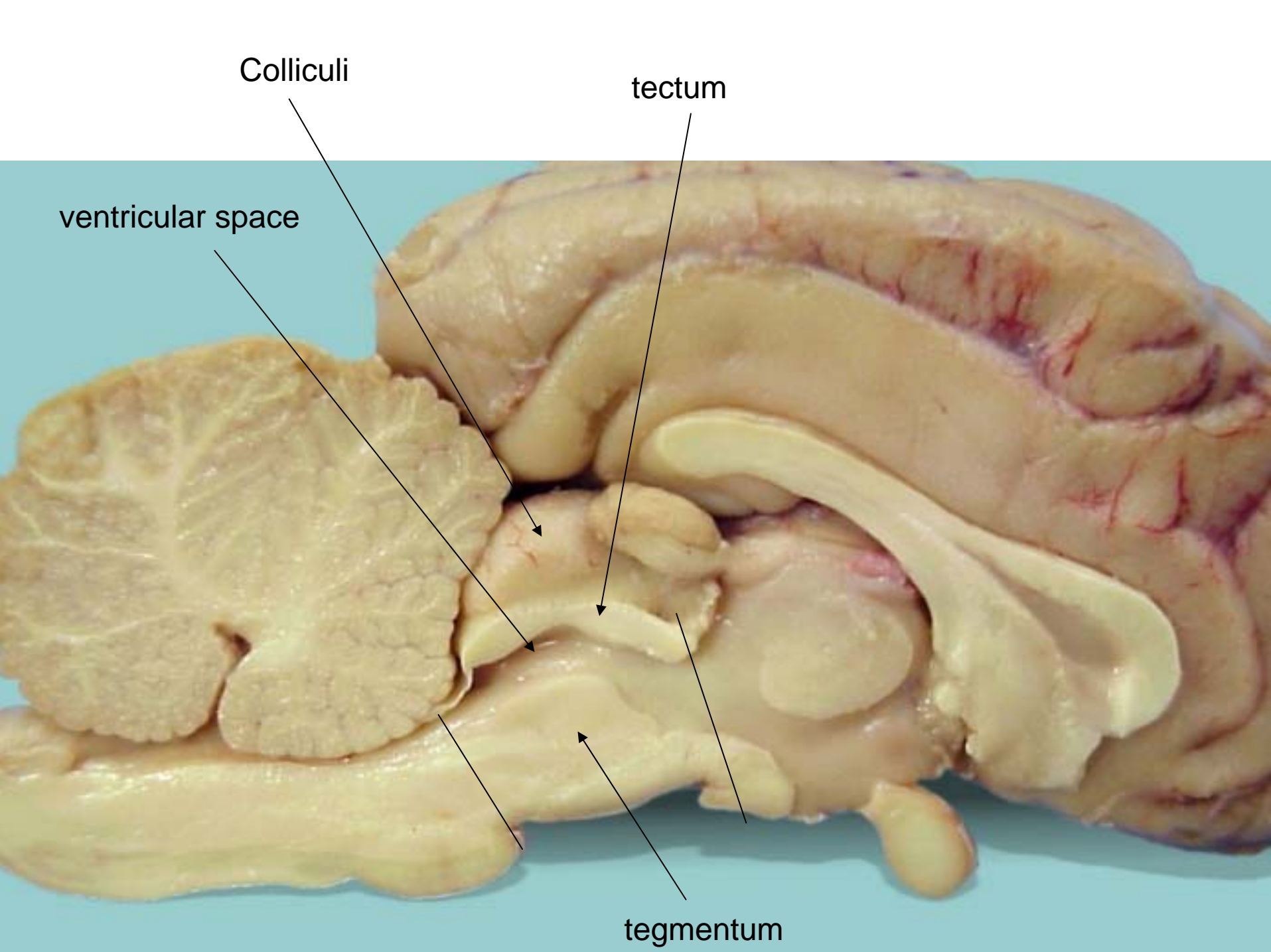
cerebellar cortex

fourth ventricle

obex

medulla oblongata





Colliculi

tectum

ventricular space

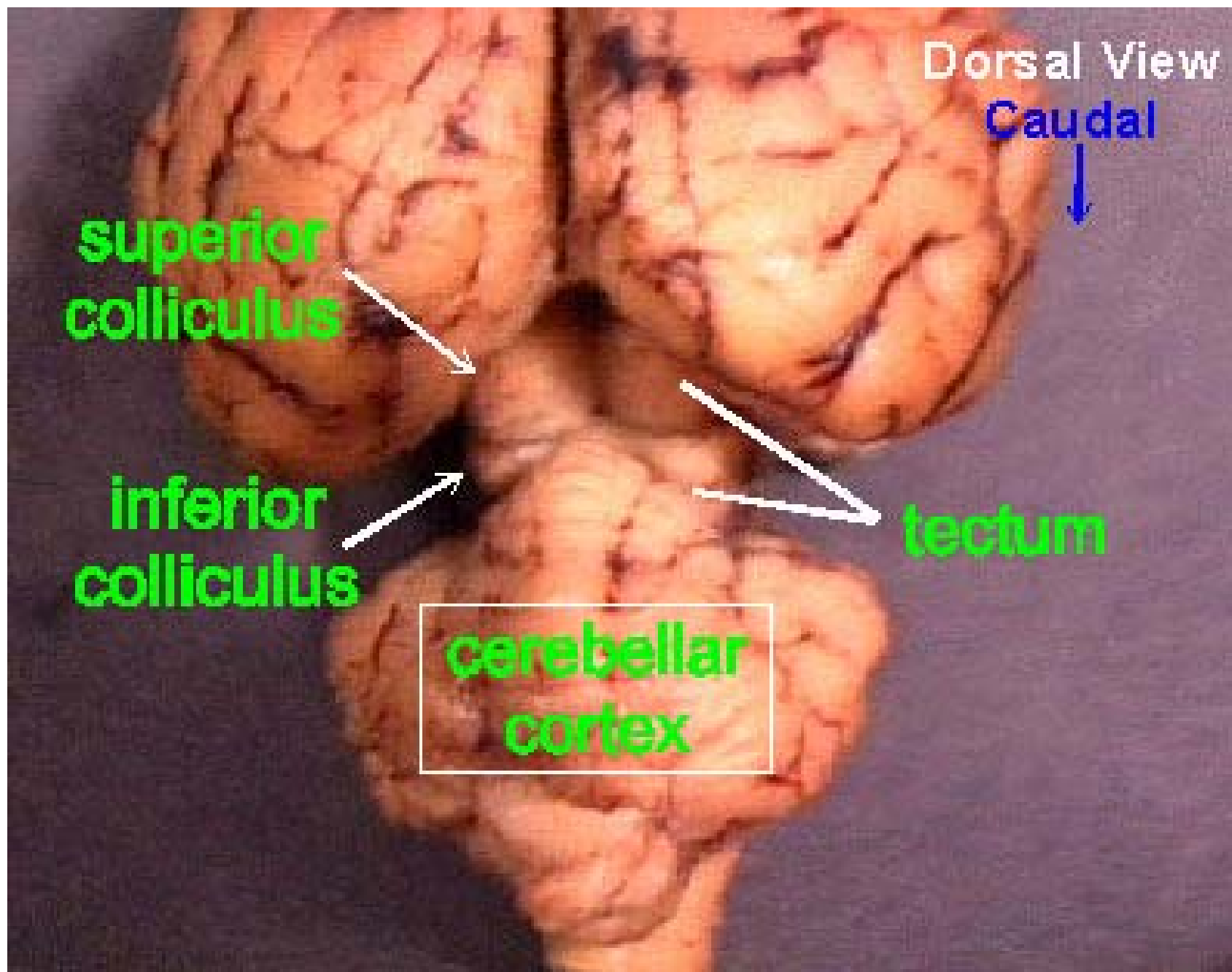
tegmentum



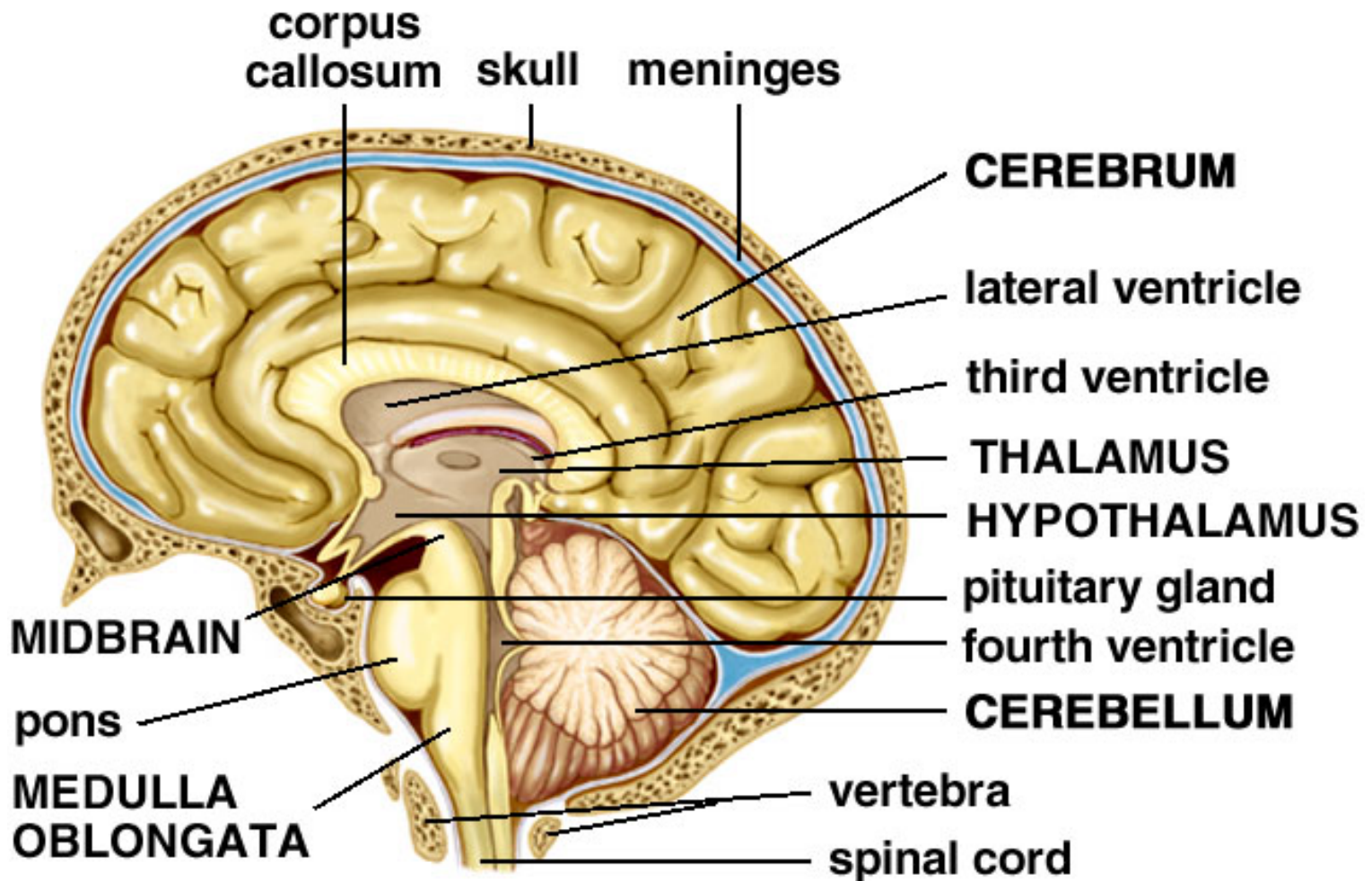
# ***Posterior to the Ventricular Space***

- The midbrain is the **only place** where this part contains a **substantial amount of neural tissue**.
- This region of the midbrain is called the **tectum** (L. roof).
- It consists of the **superior and inferior colliculi**.



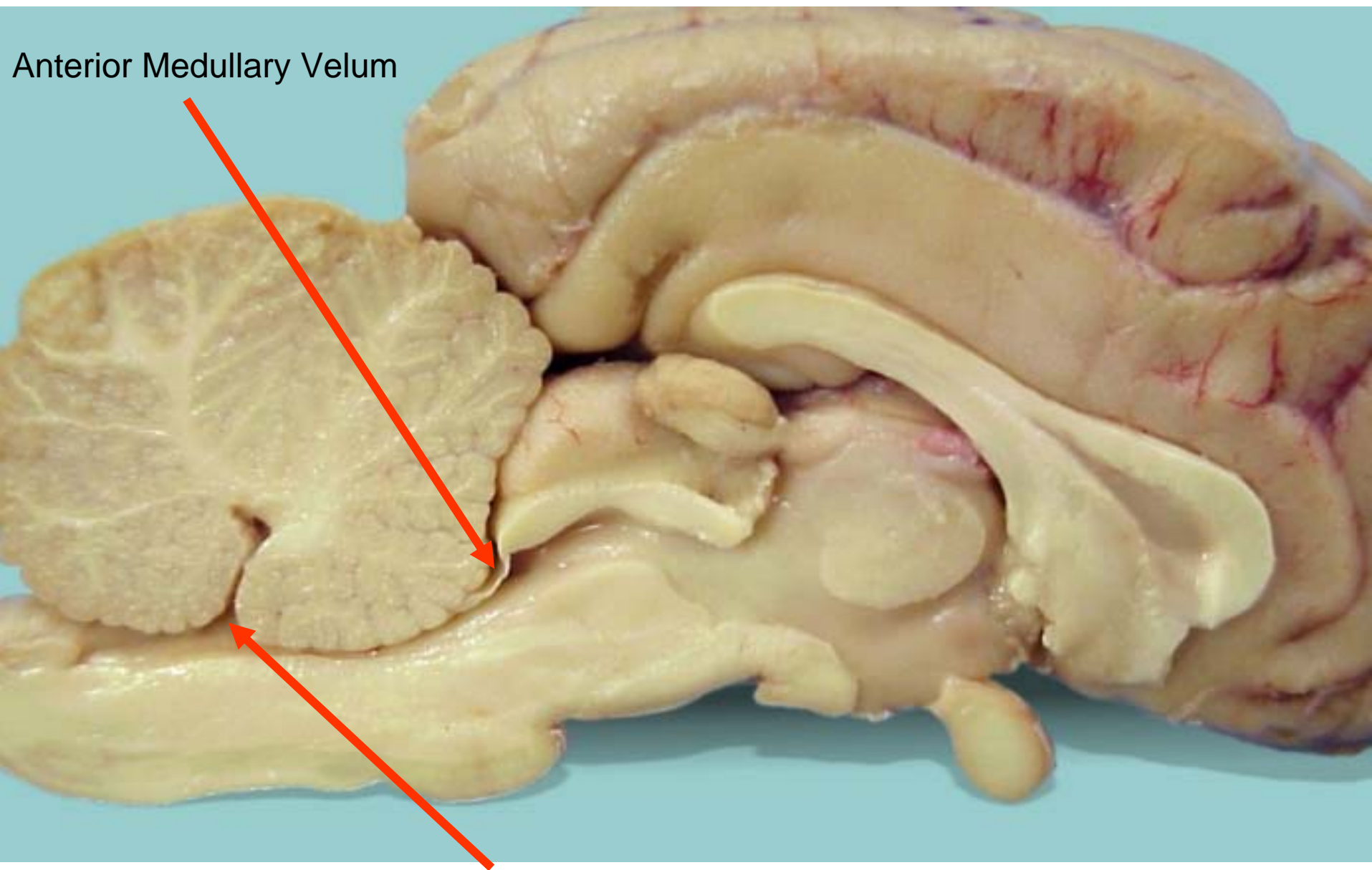


# The Human Brain



- In the pons and **rostral medulla**, the **4th ventricle** is **covered posteriorly** by the **superior and inferior medullary vela**.
- Posterior to these, of course, is the **cerebellum**.

Anterior Medullary Velum

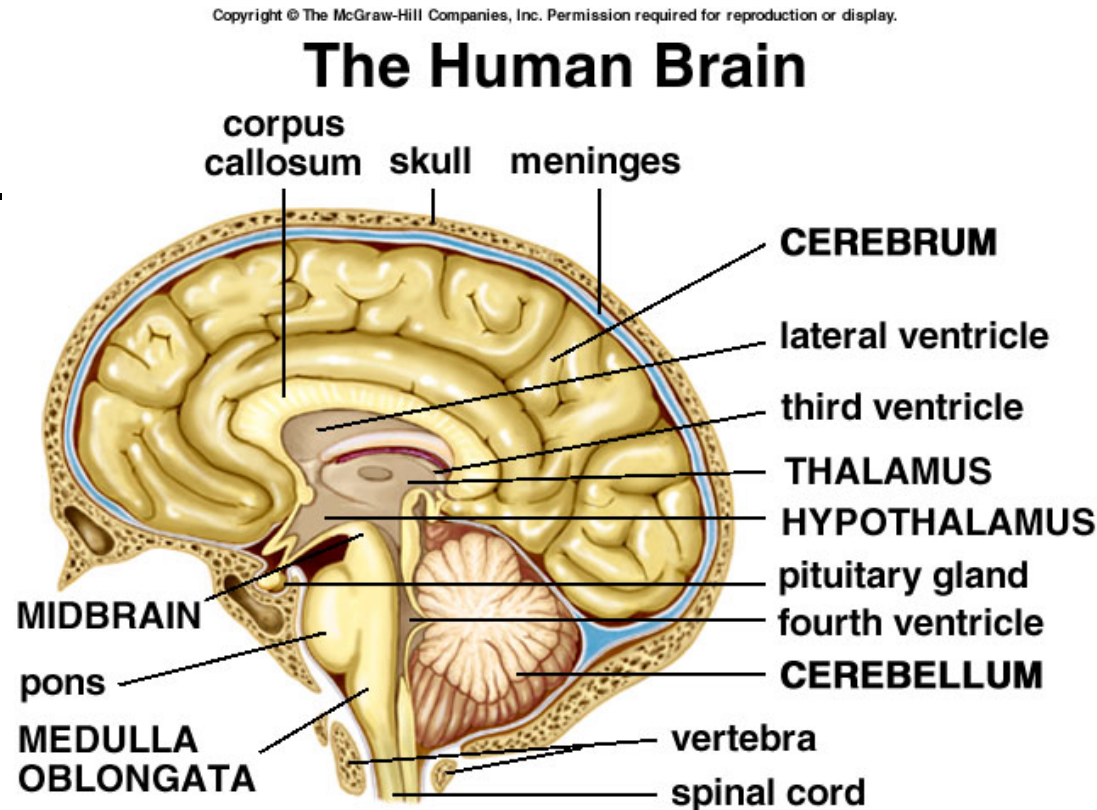


4<sup>th</sup> Ventricle



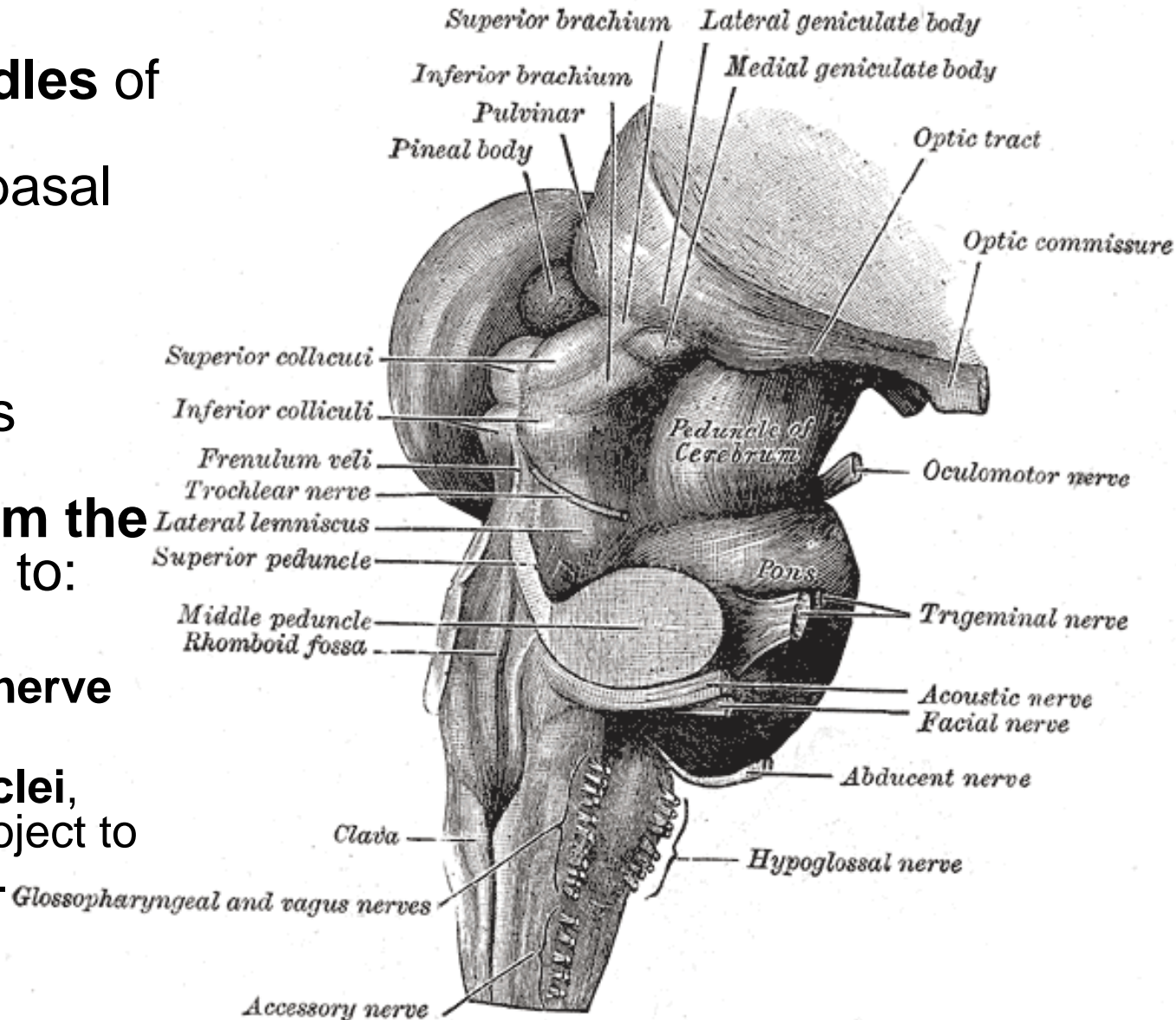
# ***Anterior to the Ventricular Space***

- This part is called the **tegmentum** (L. covering).
- The tegmentum contains most of the structures:
  - the reticular formation,
  - **cranial nerve nuclei and tracts**,
  - ascending pathways from the **spinal cord**, and some descending pathways.



# Structures Appended to the Anterior Surface

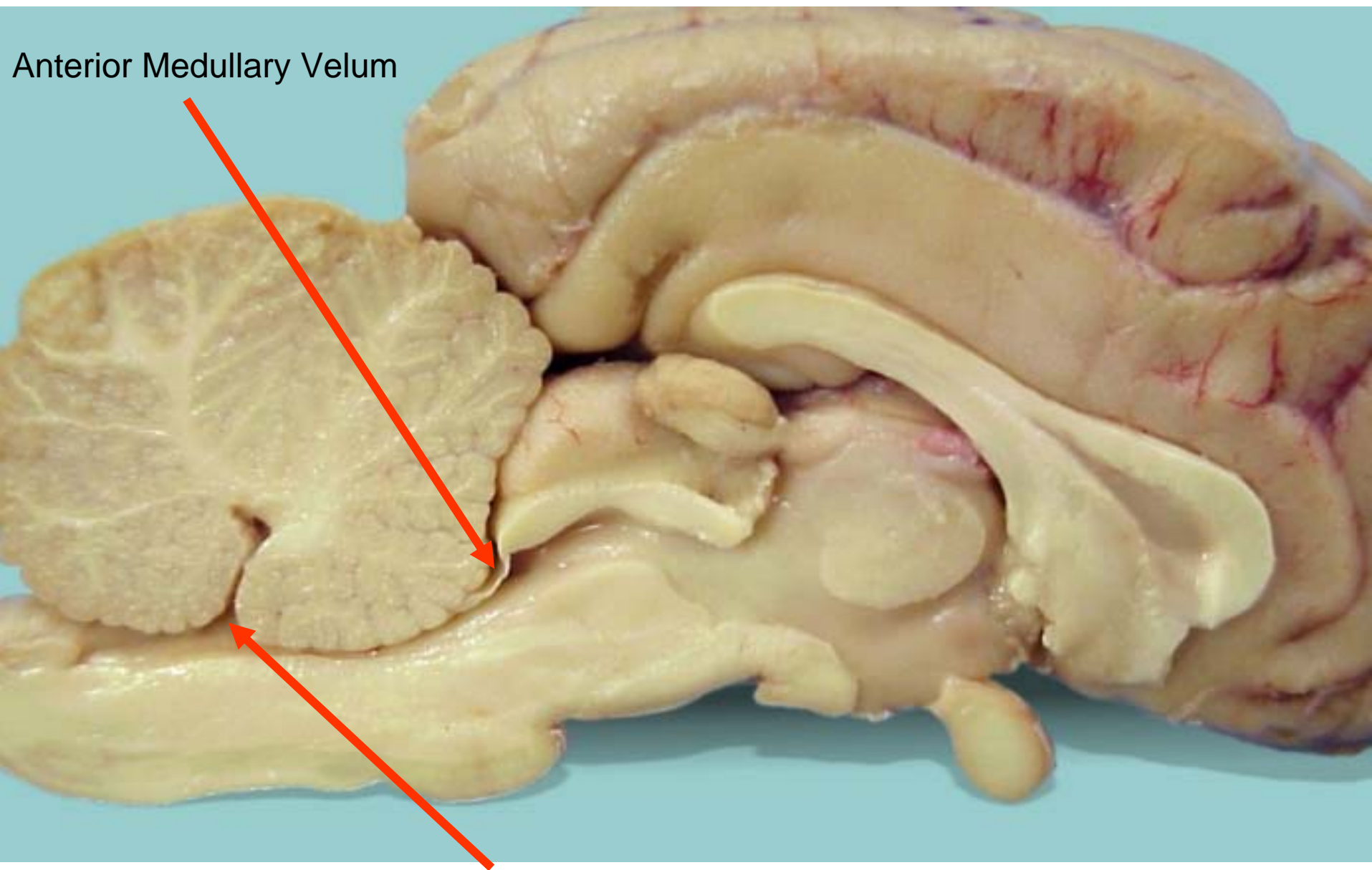
- **large fiber bundles** of the cerebral peduncles, the basal pons, and the pyramids of the medulla.
- These structures contain **fiber descending from the cerebral cortex** to:
  - the spinal cord;
  - certain **cranial nerve nuclei**
  - the **pontine nuclei**, which in turn project to the **cerebellum**.



# Midbrain

- **Tectum**- rooflike region dorsal to the aqueduct consisting of the Corpora Quadrigemina
- Corpora quadrigemina (Superior and inferior colliculi) - visual reflexes & relay center for auditory information.
  - **Two pairs of rounded knobs on the upper surface of the midbrain** mark the location of four nuclei, which are called collectively the "corpora quadrigemina."
  - These masses contain the **centers for certain visual reflexes**, such as those responsible for moving the eyes to view something as the head is turned. They also **contain the hearing reflex centers** that operate when it is necessary to move the head so that sounds can be heard better.

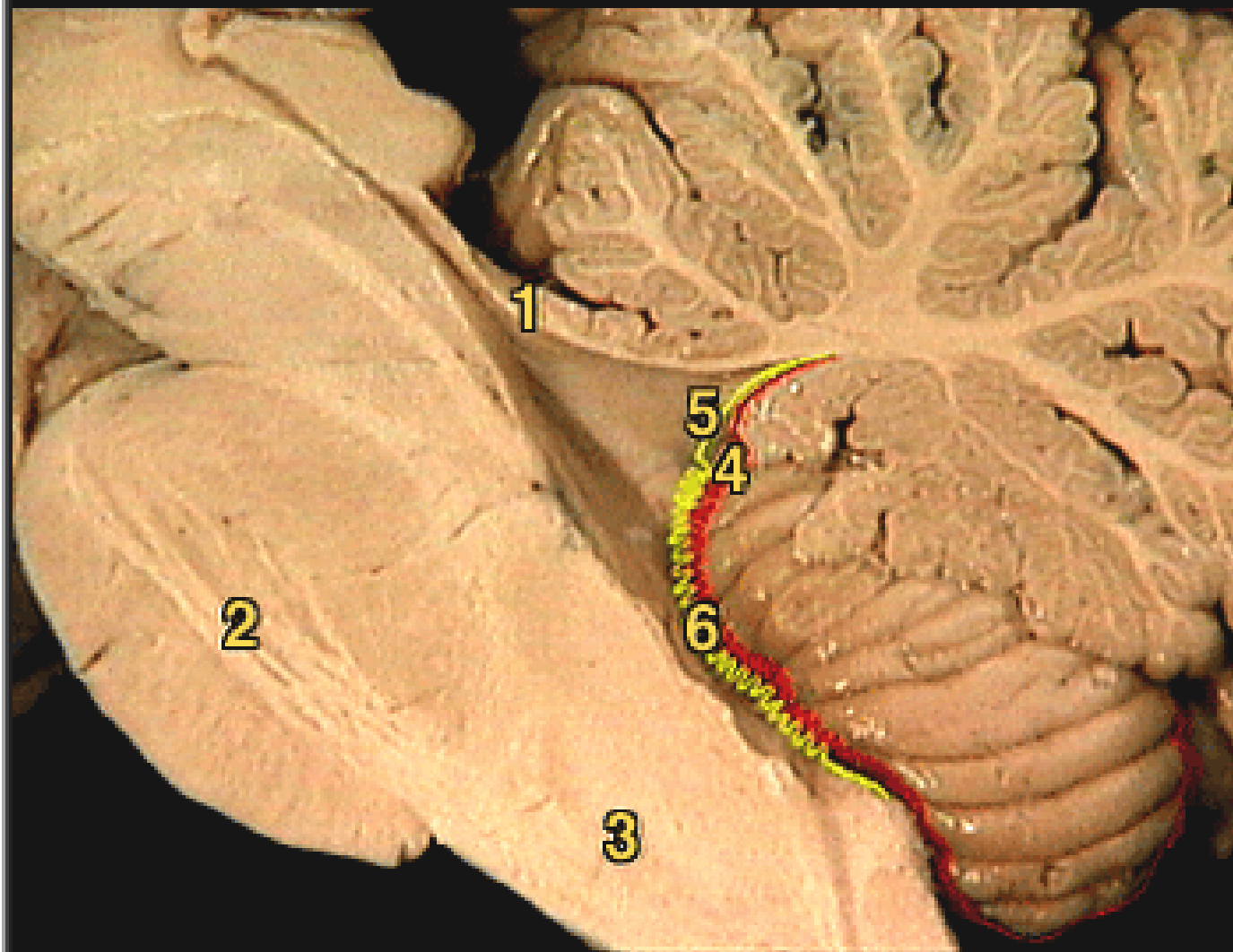
Anterior Medullary Velum



4<sup>th</sup> Ventricle

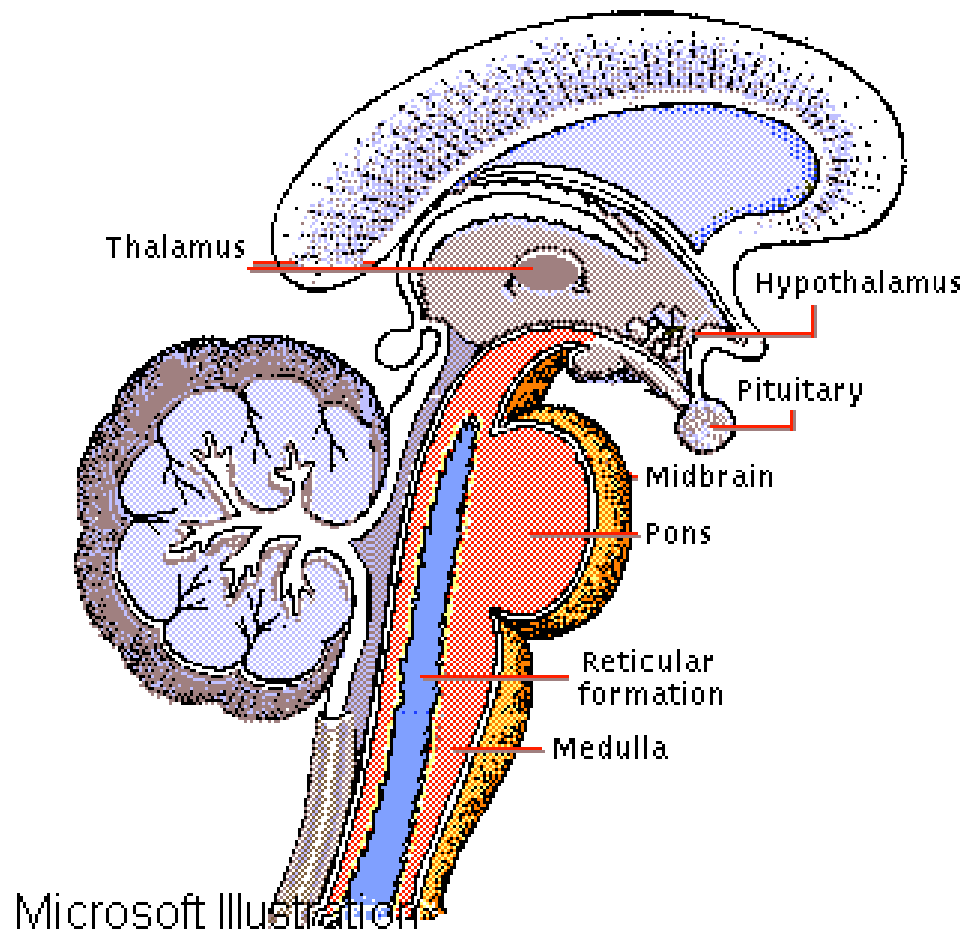


1. Superior medullary velum
2. Pons
3. Medulla oblongata
4. Pia mater
5. Ependyma
6. Choroid plexus



# Midbrain

- Contains the rostral end of the **reticular formation** (which results in the loss of consciousness or coma if impaired).



# Midbrain

- The ventral or anterior part has the **cerebral peduncle**, which is a huge bundle of axons traveling from the cerebral cortex into/ through the brainstem; fibers are important for voluntary motor function.
- **Red nucleus**- so named because they have a pinkish color in fresh Brain specimens, because of an abundant Blood supply. The red nuclei aid in the unconscious regulation and coordination of motor activities.

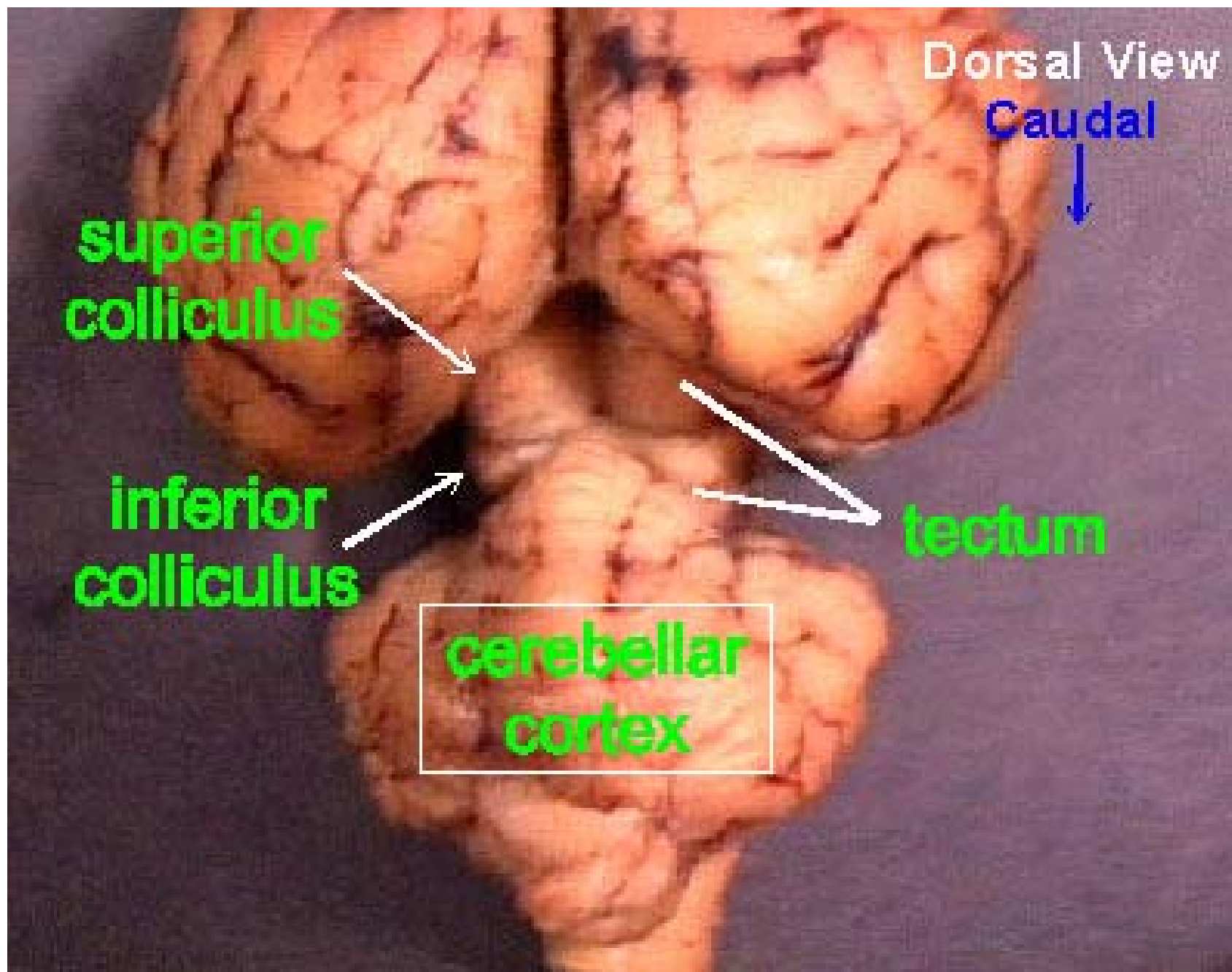
# Midbrain

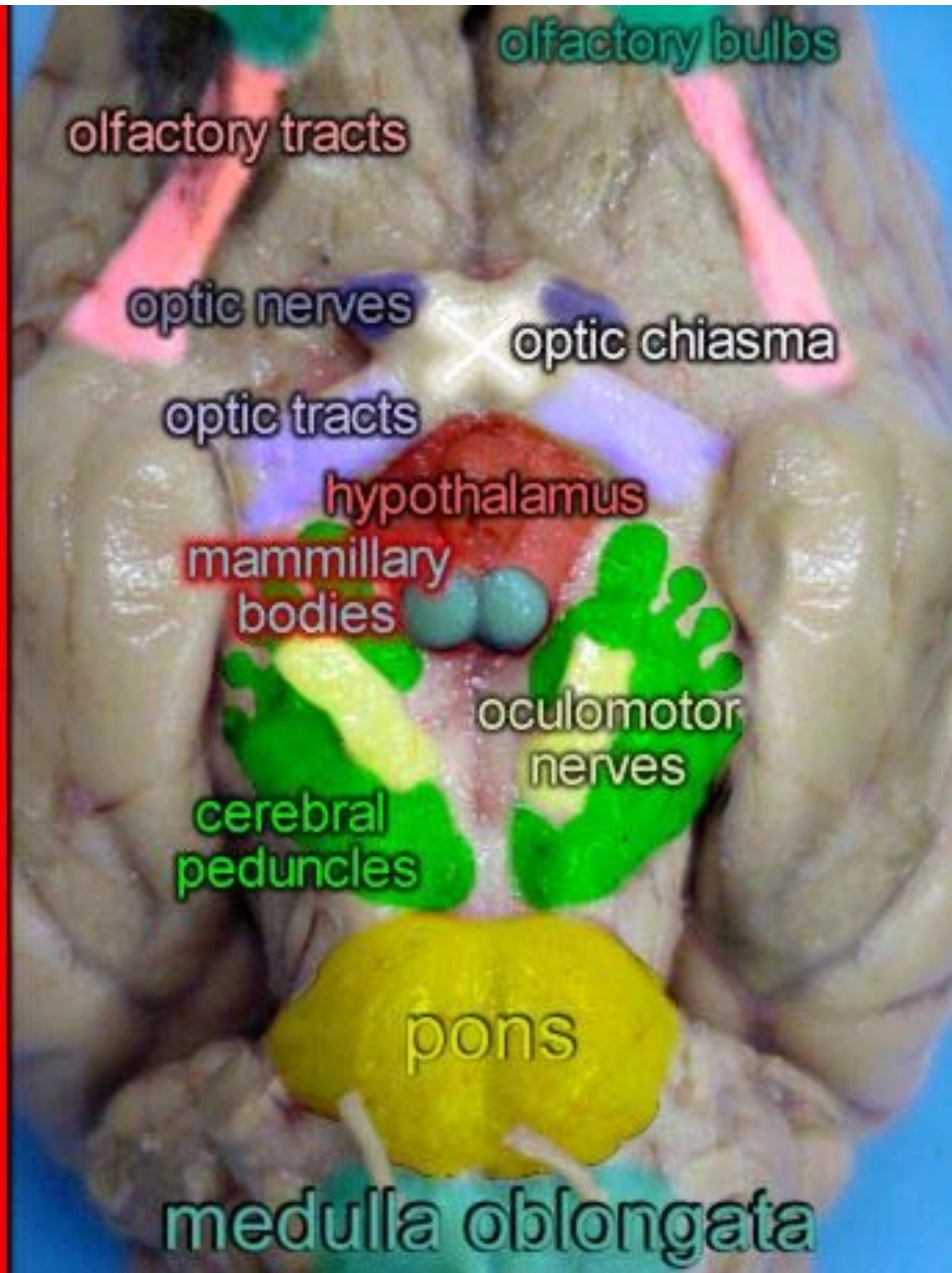
## **Substantia nigra-**

- A nuclear mass between the Tegmentum and Cerebral Peduncles, is a pigmented region of the midbrain with cytoplasmic Melanin Granules that give it a dark gray-to-black color.
  - has interconnections with other Basal Ganglia Nuclei of the Cerebrum and is involved in Coordinating Movement and Muscle Tone.
- Sends inhibitory signals to the thalamus and basal ganglia
- Degeneration of the neurons leads to muscle tremors of Parkinson's disease

# Midbrain

- **Medial lemniscus-** a continuation of the gracile and cuneate tracts of the spinal cord and brainstem
- Contains two cranial nerve nuclei that control eye movement: **Cranial Nerves III (Oculomotor) and IV (Trochlear).**



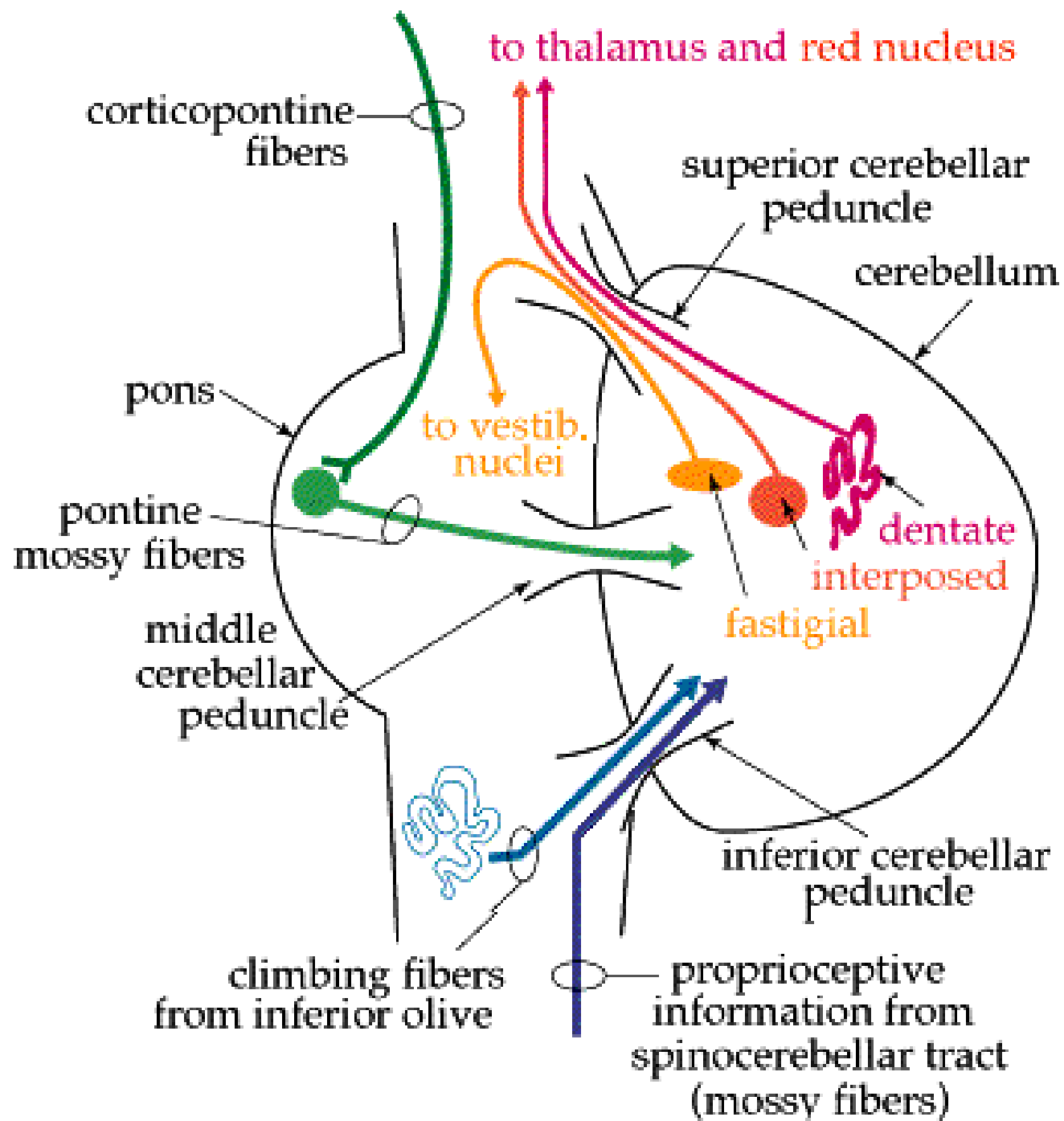


**Ventral View**

# Pons

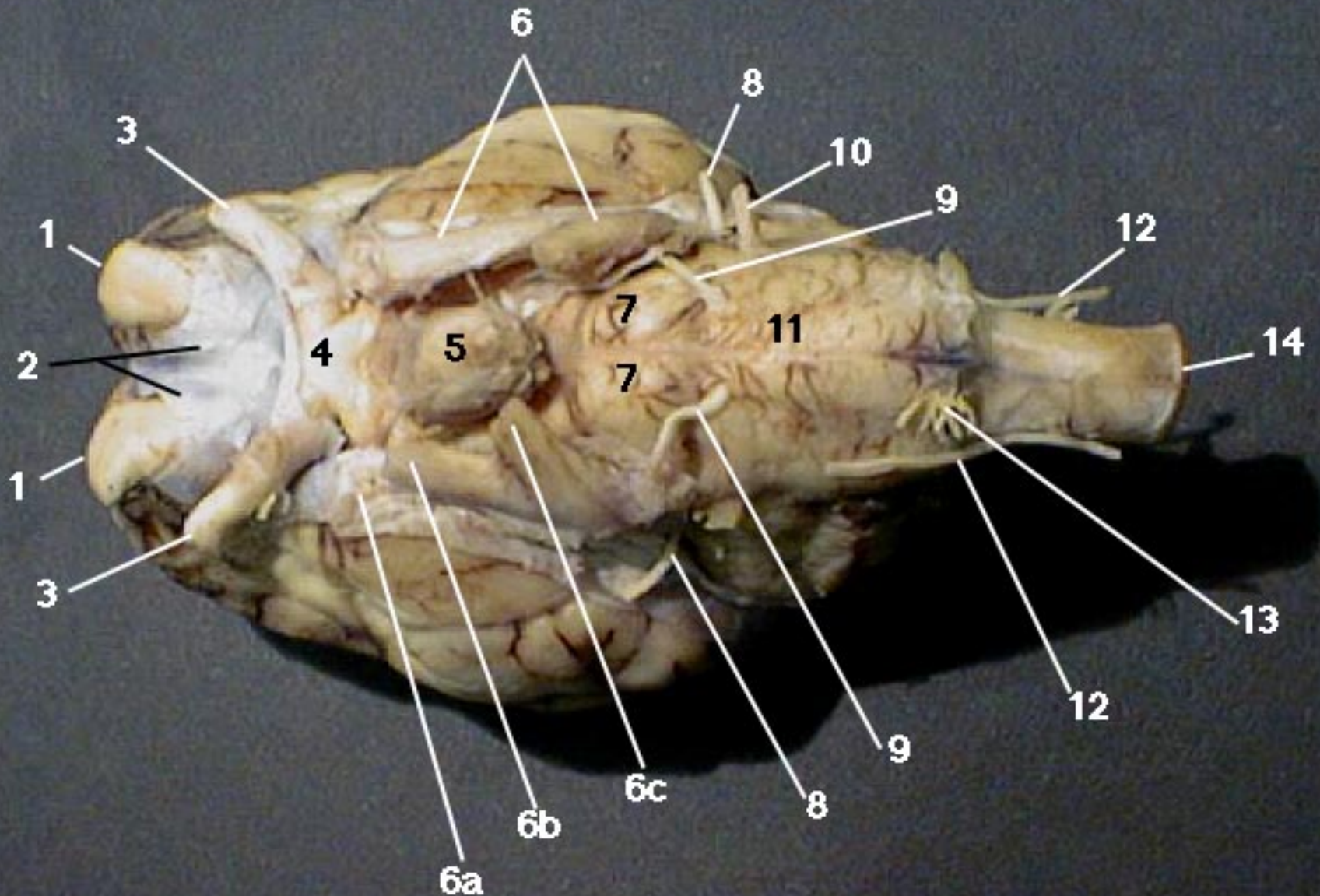
- The pons (L. bridge) is dominated by the massive, transversely oriented structure on its ventral surface called the **basal pons** it and looks like a bridge interconnecting the two cerebellar hemispheres. It **does not**, however, interconnect them.
- Many of the fibres **descending** in a cerebral peduncle synapse in **scattered pontine nuclei** which acts as relay station that connects the motor cortex with the cerebellum concerning the coordination of voluntary movements.
- These connections are made via the **middle cerebellar peduncles**





## The Entry and Exit of Cranial Nerves around the Pons

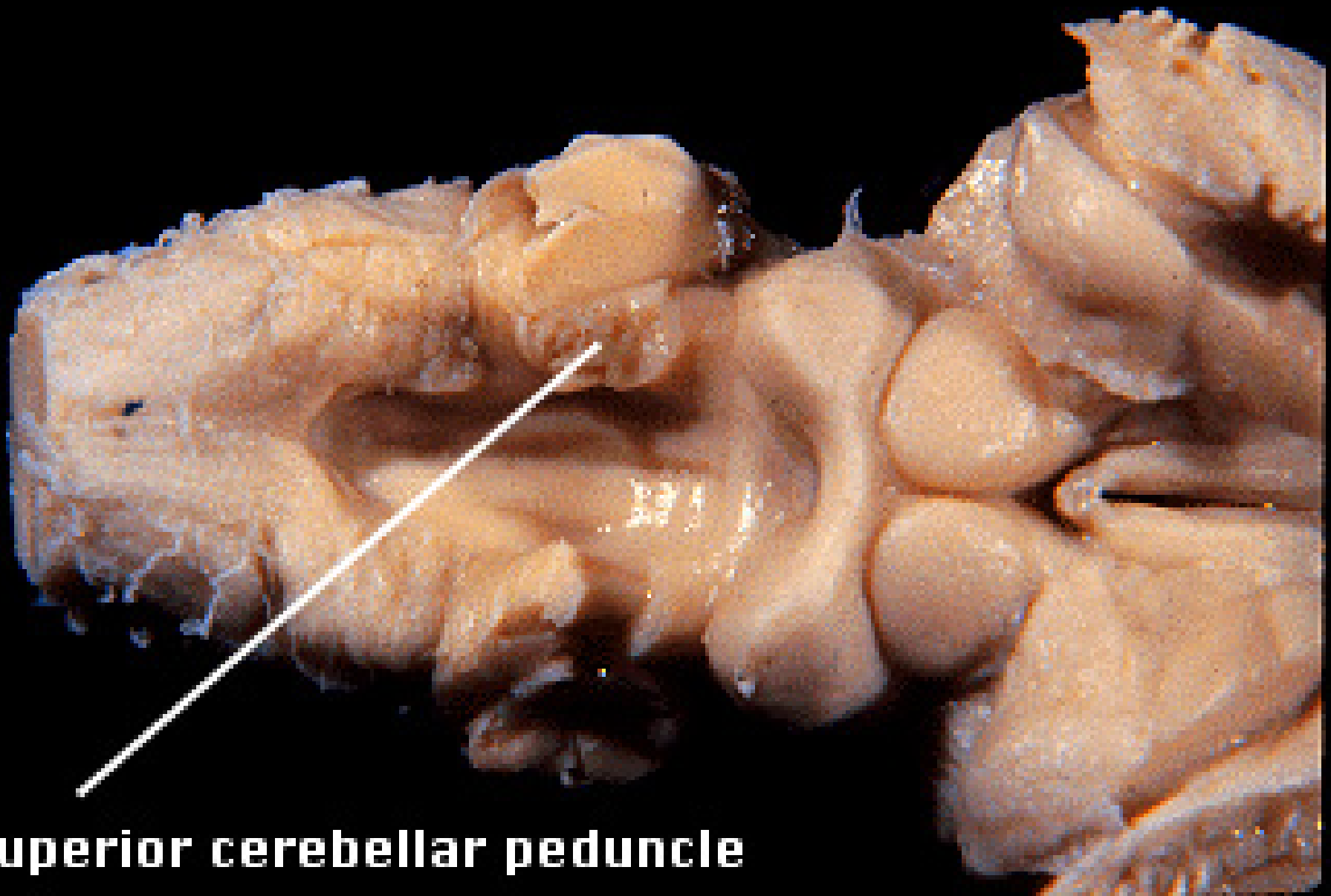
- The **trigeminal nerve** (CN V-innervates the face and chewing muscles) **enters the brainstem** at the **midpons**.
- Three other cranial nerves enter (or leave) along the **groove between the basal pons and the medulla**;
- The **abducens nerve** (CN VI- innervates an eye moving muscle) is the **smallest** and **most medially located** of these three, exiting where the **pyramid emerges** from the **basal pons**;
- The **facial nerve** (CN VII- supplies muscles of facial expression) is **farther lateral** and consists of **two parts**: a **larger and more medial motor root** and a **smaller sensory root** (sometimes referred to as the *intermediate nerve*);



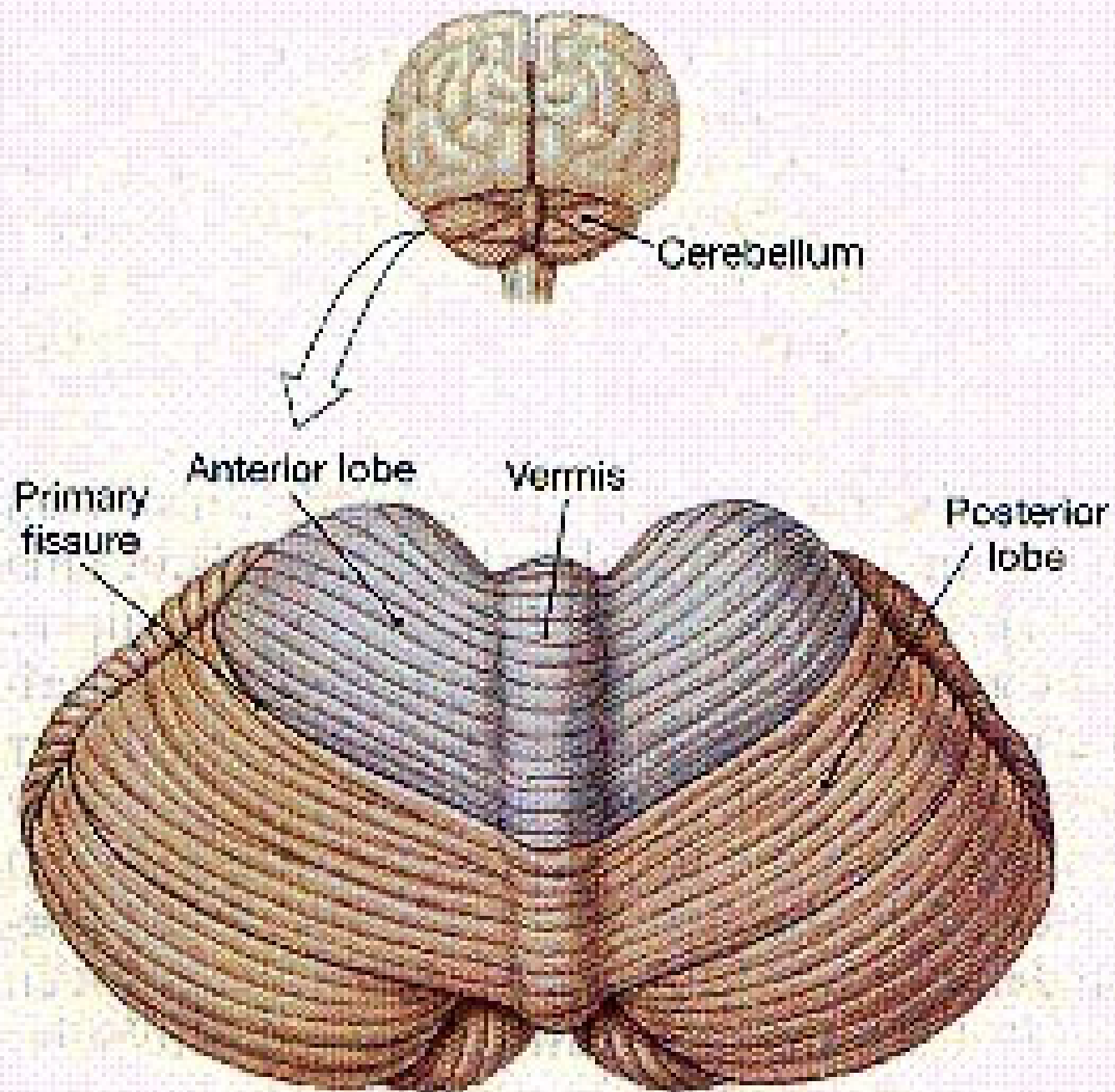
1.Olfactory Bulbs (I) 2. Dura Mater 3. Optic Nerve (II) 4.Optic Chiasm 5.Pituitary Gland (Hypophysis) 6a.Trigeminal Nerve (V) - Ophthalmic Branch (V) 6b.Trigeminal Nerve (V) - Maxillary Branch (V) 6c.Trigeminal Nerve (V) - Mandibular Branch (V) 7.Pons 8.Vestibulocochlear Nerve (VIII) 9.Abducens Nerve (VI) 10.Facial Nerve (VII) 11.Medulla Oblongata 12.Spinal Accessory Nerve (XI) 13 Hypoglossal Nerve (XII) 14 Spinal Cord

## **The Entry and Exit of Cranial Nerves around the Pons**

- The **vestibulocochlear nerve (CN VIII)** is **slightly lateral** to the **facial nerve** and also has **two parts**: a **vestibular division** and a **more lateral cochlear division**.
- **trochlear nerve (CN IV-** innervate eye movement muscle) emerges from the **dorsal surface** of the **brainstem** **between the junction of the pons and midbrain**



**Superior cerebellar peduncle**





### Lobules of Vermis

- |   |                |
|---|----------------|
| 1 | Lingula        |
| 2 | Central lobule |
| 3 | Culmen         |
| 4 | Declive        |
| 5 | Folium         |
| 6 | Tuber          |
| 7 | Pyramis        |
| 8 | Uvula          |
| 9 | Nodulus        |

### Brainstem Anatomy

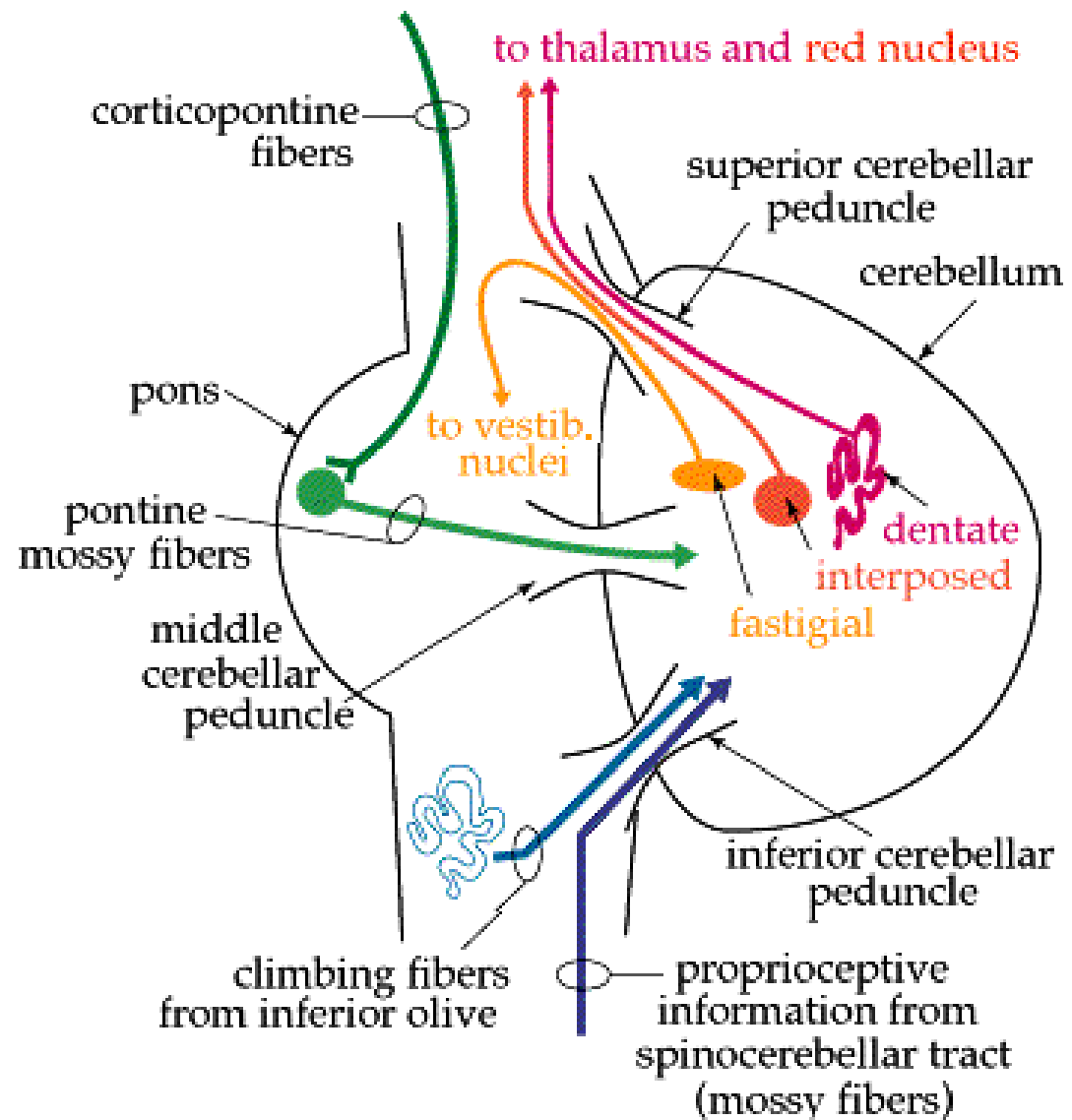
- |   |                        |
|---|------------------------|
| A | Midbrain               |
| B | Pons                   |
| C | Medulla                |
| D | Cerebral aqueduct      |
| E | Fourth ventricle       |
| F | Primary fissure        |
| G | Posterolateral fissure |

# The Cerebellum ("little brain")

- The cerebellum is involved in the coordination of movement
- it compares what you thought you were going to do (according to motor cortex) with what is actually happening down in the limbs (according to proprioceptive feedback), and corrects the movement if there is a problem.
- is also partly responsible for motor learning, such as riding a bicycle.
- Unlike the cerebrum, which works entirely on a contralateral basis, the cerebellum works ipsilaterally.

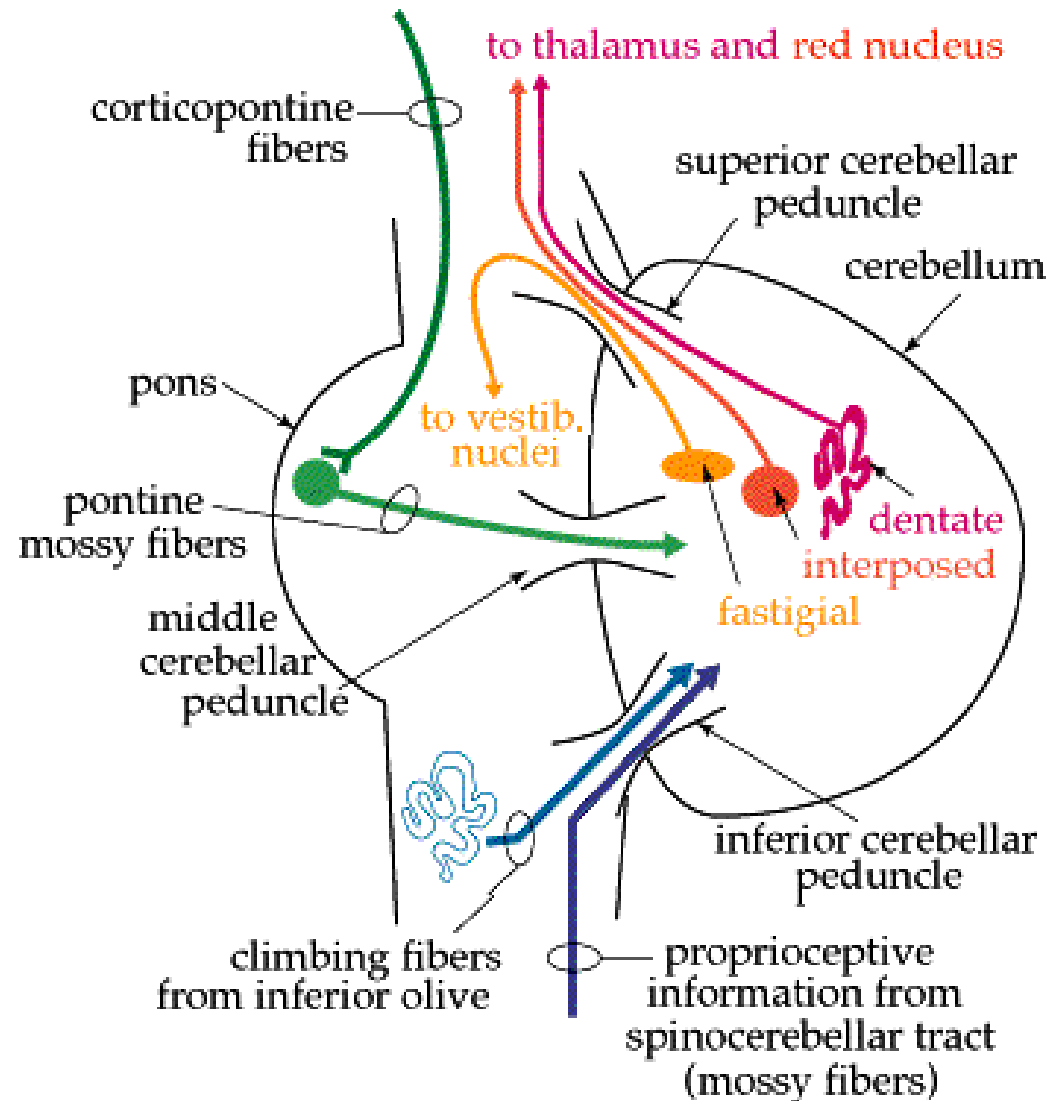


- The cerebellum operates in 3's:
  - there are 3 highways leading in and out of the cerebellum,
  - there are 3 main inputs, and
  - there are 3 main outputs from 3 deep nuclei. They are:



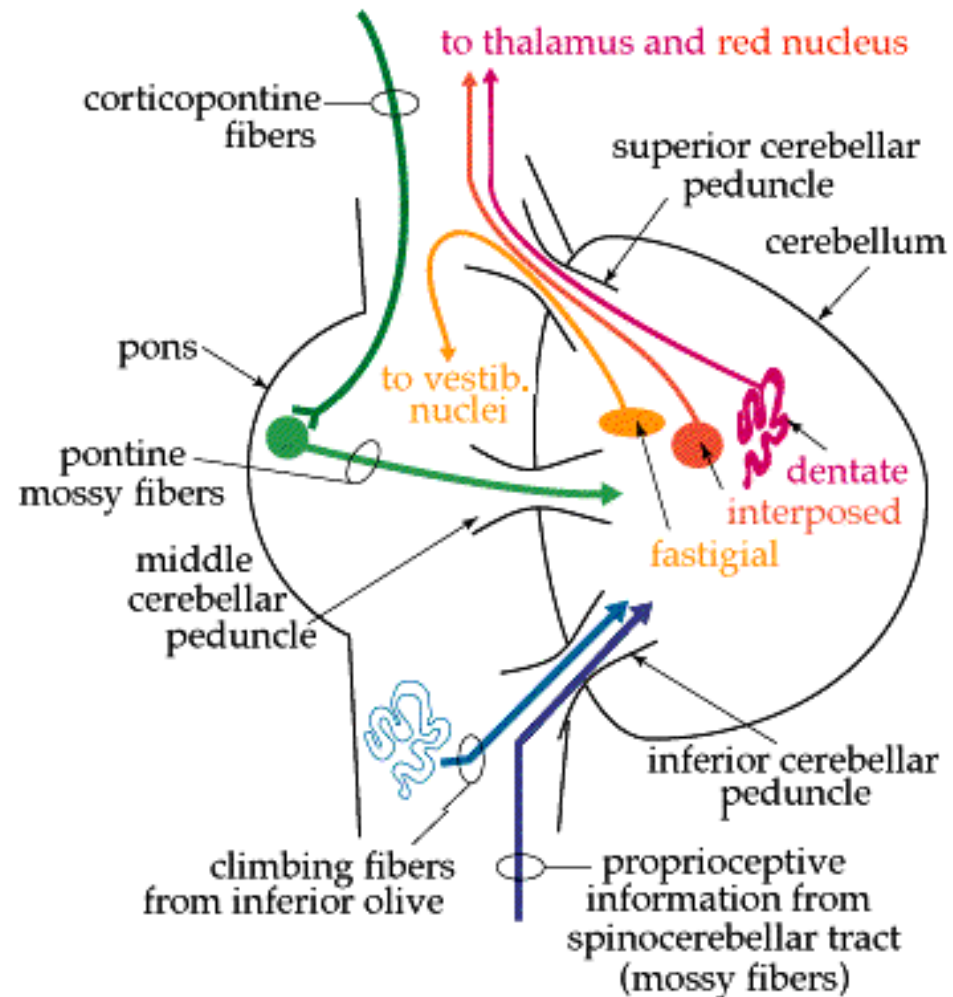
# CEREBELLAR PEDUNCLES

- bundles of fibers connecting the cerebellum with the underlying brain stem
- There are 3 pairs:
  - **inferior**- transmit info about ongoing movement from spinal cord
  - **middle**- sensory info from pons
  - **superior-main output path**
    - info to thalamus and brain stem
    - info to red nucleus of midbrain (red nucleus relays info from cerebellum to spinal cord)

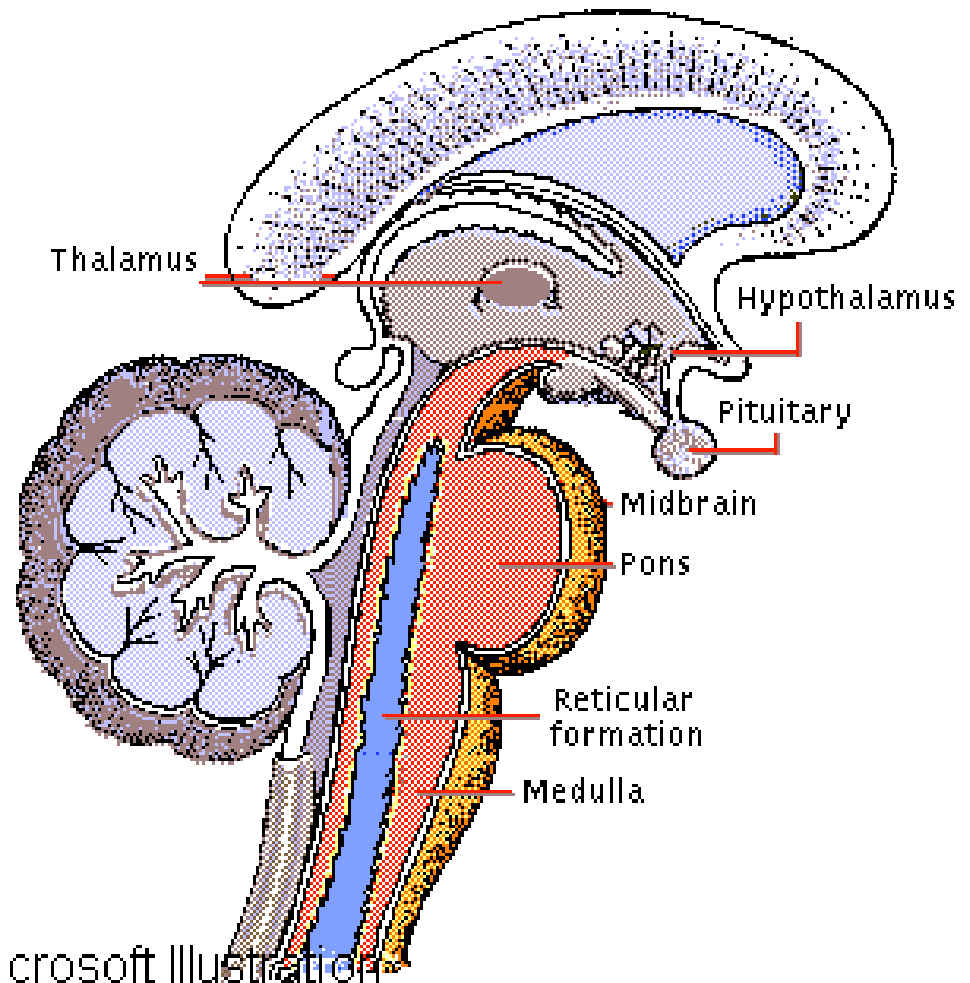


The 3 deep nuclei are the

- **fastigial**- is primarily **concerned with balance**, and sends information mainly to vestibular and reticular nuclei.
- **interposed**, and **dentate nuclei**- are concerned more with **voluntary movement**, and send axons mainly to thalamus and the red nucleus.
- Cranial nerve nuclei VIII-XII



- The core of the medulla contains much of the reticular formation some of which influence the autonomic (visceral motor) functions
  - cardiac center- adjust the frequency and rate of heartbeat
  - vasomotor center- regulates blood pressure by controlling blood vessel dilation and constriction
  - medullary respiratory center controls the basic rhythm and rate of breathing
  - additional centers regulate hiccuping, swallowing, coughing and sneezing.



↑  
Diencephalon and  
telencephalon

Midbrain

Basis  
pedunculi

Pons

Medulla

Cervical  
ventral  
roots

Pyramid

Optic nerve (II)

Optic chiasm

Optic tract

Oculomotor nerve (III)

Trigeminal nerve (V)

Abducens nerve (VI)

Facial and intermediate  
nerves (VII)

Vestibulocochlear  
nerve (VIII)

Glossopharyngeal (IX)  
and vagus nerves (X)

Hypoglossal nerve (XII)

Accessory nerve (XI)

Pyramidal decussation

